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# Increasing demands on information systems and infrastructures for complex decision-making

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To extend the development of cumulative theory on the enduring themes of Information Systems (IS), we take an historical perspective of a core topic within the field, namely Decision Support Systems (DSS). Motivated by the complexity of strategic decision-making within the Climate Change Working Group of the State Government of New South Wales, we conducted a content analysis of IT strategy documentation from 1989 to the present. In our analysis of the resulting concept maps we observe the increasing dynamism and complexity of DSS over this period and suggest that we are now entering a critical era for IS in dealing with such dynamism and complexity. Crucial issues such as climate change now require planning over much longer time frames (up to 100 years) than are currently considered by either government or business. The decision-making of the Working Group calls for the integration of very large data sets and the sharing of information from many different government agencies and external sources. In a pattern of distributed leadership there is an increase in participation from citizens in decision-making for local climate change initiatives often through social media. We re-evaluate DSS not as IS but as a broad 'information infrastructure' which can flexibly and rapidly adapt to the needs of specific projects.



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# INCREASING DEMANDS ON INFORMATION SYSTEMS AND INFRASTRUCTURES FOR COMPLEX DECISION-MAKING

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## Abstract

*To extend the development of cumulative theory on the enduring themes of Information Systems (IS), we take an historical perspective of a core topic within the field, namely Decision Support Systems (DSS). Motivated by the complexity of strategic decision-making within the Climate Change Working Group of the State Government of New South Wales, we conducted a content analysis of IT strategy documentation from 1989 to the present. In our analysis of the resulting concept maps we observe the increasing dynamism and complexity of DSS over this period and suggest that we are now entering a critical era for IS in dealing with such dynamism and complexity. Crucial issues such as climate change now require planning over much longer time frames (up to 100 years) than are currently considered by either government or business. The decision-making of the Working Group calls for the integration of very large data sets and the sharing of information from many different government agencies and external sources. In a pattern of distributed leadership there is an increase in participation from citizens in decision-making for local climate change initiatives often through social media. We re-evaluate DSS not as IS but as a broad 'information infrastructure' which can flexibly and rapidly adapt to the needs of specific projects.*

*Keywords: Decision Support Systems, Information Infrastructure, Climate Change Adaptation, Content Analysis, Complexity*

# INTRODUCTION

In this paper we take an historical perspective of the development of one of the core topics within the field of Information Systems (IS). This topic concerns the design and role of strategic Decision Support Systems (DSS) in providing information for management decision-making. In a comprehensive review of the DSS literature from 1990 to 2004, Arnott and Pervan (2008) observe the "lack of a cumulative tradition that yields strong theoretical models" and suggest that this is in part due to the "dynamism of information technology". This problem was echoed during the discussion at the final plenary session of the Australasian Conference on Information Systems in December 2011 when Prof Wanda Orlikowski referred to a recent paper (Feldman & Orlikowski 2011) noting that too many small theories were proposed from the findings of individual IS research studies and not enough cumulative theory was being developed on the broader enduring IS themes such as DSS. We aim to present a case of two decades of decision support that indicate a different paradigm of IS is emerging from a combination of current global challenges and the universal engagement in social media.

This paper recognises that the inherent dynamism of IT has driven the evolution of information systems to span constituencies from a single department, then to the enterprise as a whole and, more recently, to multi-organisational entities such as supply chains. The site of our research, the State Government of New South Wales (NSW), is a very large multi-agency organisation. We present findings from an historical analysis of the NSW Government's IT strategy over the past twenty-two years in order to make sense of the evolution of their decision support mechanisms over that time. This investigation was motivated by a recent field study of governmental climate change adaptation activities which revealed the complexity of the task and the difficulties faced in providing task leaders with information for essential decision-making both within and outside government. These activities required an unprecedented long-term whole of government approach to the integration of large data sets and the sharing of information from many different government agencies and external sources.

In order to learn from any similar historical large-scale endeavours by this government, a content analysis was undertaken of IT strategic planning and associated documents from 1989 to 2011 using a concept mapping tool, Leximancer. The prominent concepts, and the relationships between them, on these maps were then further informed by key review articles from the IS/DSS literature from each time period. While the distribution of concepts on maps from the historical documents show a typically even two-dimensional spread, the map from the 2011 documents exhibited a surprising form showing an almost one dimensional bipolar distribution of concepts. We argue, with reference to recent literature, that this may be due to the complexity of the current challenges facing strategic decision-makers on critical issues such as climate change together with the increasing involvement of citizens in public affairs through social media. This may require a re-evaluation of the perception of a DSS where it is not viewed as an 'information system' but rather as a broad 'information infrastructure' which can flexibly and rapidly adapt to the particular needs of specific projects.

# 1 BACKGROUND

The idea that we need information in order to make good decisions is not unique to the digital age but has been a particular focus of in-depth analysis since the advent of computers. The term 'Information Technology' first appeared in the literature in the early 1960's (e.g. Diebold, 1962; Emery, 1964). As computers were taken up for commercial use it was recognised that in addition to performing essential 'data processing' they also produced information from that data which could be used to support sense-making, decision-making and action (Shim et al 2002). Although the concept of 'Decision Support Systems' (DSS) also appeared in the early 1960's (Goertzel, 1969), DSS technology and operational applications became more common in the 1970s and have evolved significantly since into more strategic areas (Shim et al 2002). While a DSS can be viewed as an IT artefact there is also an DSS phenomenon that has become one of the core themes of research within the field of IS.

In the IS discipline there is debate on the relationship between the IT artefact and the phenomena that become the object of the research and theory. It is argued that IS research constructs should be

intimately related to the IT artefact (Benbasat & Zmud 2003) and that theorizing about IT artefacts should be at the core of IS research projects (Orlikowski & Iacono 2001). In this paper we are concerned with the general phenomenon of information and information systems support for decision-making as the context of our study much more complicated than that of a single DSS. Clark et al (2007) refer to the need for a "new theory of management decision support that focuses on a broader context than does the traditional DSS to include business processes, organizational members, technology, infrastructure, and organizational outcomes from using the systems." These authors note that most studies which focus on the DSS artefact apply linear models of success and are severely limited. Those charged with the leadership of complex tasks experience circumstances where decision support is much more complex than that portrayed by a linear flow.

In the review of DSS research publications by Arnott and Pervan (2008), the works most cited in DSS papers are those of Simon (1977), Newell and Simon (1972) and Mintzberg et al (1976), all of which observe that human decision making can appear at times to be well-informed, rational and structured, while at others quite unstructured based on intuition. This work in the 1970s was followed by other (e.g. Sprague & Carlson 1982; Turban &Watkins 1986; Eierman et al 1995) and expanded to the area of Group DSS (DeSanctis & Gallupe 1987) and issues associate with Business Intelligence. Many of the more recent DSS articles refer to increasing complexity (Filip 2008) and dynamism (Clark et al 2007) recognizing that the technical and social systems of the present day are ever more large, complex and complicated. This recognition of growing complexity and dynamism underlies the drive to supplant the notion of 'information system' with that of 'information infrastructure' (Ciborra 2000; Hanseth & Lyytinen 2010) as the mechanism for decision support in multi-faceted enterprises such as state governments. Our field study of the NSW State Government Climate Change Working Group (CCWG) is a case in point which we now describe.

# 2 THE CONTEXT AND METHOD OF THE STUDY

The challenges of complex problems such as climate change are placing increasing demands on the nature and role of information and information systems in enabling decision-making and action. The Green IS literature to date has focused almost exclusively on the role of IS in mitigating climate change led by the work of Watson et al. (2010) on energy informatics. The equally important challenges of adaptation have been neglected.

Climate change adaptation refers to "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (IPCC 2007, p. 76). The context for adaptation is the belief that it may already be too late to prevent some effects of climate change, and that government, organizations and citizens must engage in actions that ensure sustainability in light of such changes (Bedsworth & Hanak 2010, Tessa & Kurukulasuriya 2010). Adaptation activities depend on extensive planning for the uncertain and turbulent, i.e. high-velocity, conditions anticipated in the future and involve complicated modelling of future scenarios.

| |
|---|
| Acceptance that climate change will impact communities, which will need government support in developing the capacity to adapt. |
| A need for a whole of government approach to climate change adaptation, as evidenced by the establishment of the CCWG. |
| The existence of risks associated with climate change that implies uncertainties with respect to adaptation activities. |
| The need for government strategies, plans, processes and culture to adapt in the context of climate change. |
| The need for citizen feedback and involvement. |

*Table 1. Adaptation Principles (DECCW 2010)*

The objective of our ongoing research is to explore climate change adaptation activities within the government sector, with a view to enhancing understanding of both the nature and role of information, systems and IT in enabling solutions to the problems created by climate change. An initial in-depth

study of the New South Wales (NSW) Government in Australia, has revealed five high-level principles for climate change adaptation (see table 1) that are driving 35 projects of the CCWG. These projects necessitate the collaborative actions of multiple governmental agencies and non-governmental bodies, and rely on the availability of large quantities of information, dynamically integrated across the databases of these agencies/bodies. This provides a challenge, opportunity and responsibility for IS expertise and knowledge to make a vital environmental contribution.

Our analysis of the CCWG projects (Smith et al 2011) indicated that the need for such dynamic integration and information sharing was not anticipated when the various agency systems were designed even where this was only a few years ago. Indeed it appears that the demand on existing systems and infrastructures by those leading these new government adaptation activities is unprecedented and continues to increase due to their critical nature and the growing complexity of the globally interconnected context in which they occur.

In order to understand this phenomenon in an historical context, we undertook a content analysis of Government IT Strategy documents available to us from 1989 to 2011. The documents were grouped by year and subjected to content analysis using Leximancer[1] to identify activities, policies and attitudes associated with data consolidation, data, information sharing and decision support in the past and how they link to other concepts. Leximancer enables an automated navigation of the complexity of a document of group of documents, identifying 'concepts' within the text, not merely keywords. It focuses on clusters of related, defining terms as conceptualised by the author, not a predefined dictionary or thesaurus. The concepts are presented in a map as an interactive display to visualise and interrogate thee concepts as well as their inter-connectedness and co-occurrence down to the original text that spawned them.

In our analysis, documents grouped by time period were first analysed using Leximancer's inbuilt intelligent algorithm to generate a ranked list of concepts and a map showing relationships between them. Some concepts were then removed as irrelevant, some merged (e.g. singular and plurals) and some concepts of interest added related to information for decision-making and cross agency information sharing. The analysis was then rerun. As concepts emerged from documents of each time period we referred to the IS literature of the time to trace the emergence of the trend to greater consolidation, inter-connected and complexity of information systems across large public organisations, in particular state governments, as their operations became more complex.

# 3 PRESENTATION AND INTERPRETATION OF THE CONTENT ANALYSIS

Indicative Leximancer Concept Maps are presented below, where:

- The brightness of a concept is related to its frequency (i.e. the brighter the concept, the more often it appears in the text).
- The brightness of links relate to how often the two connected concepts co-occur closely within the text. Only some links are shown to avoid unnecessary clutter.
- Nearness in the map indicates that two concepts appear in similar conceptual contexts

Leximancer also enables the user to drill down to the text associated with concepts and links between them and sample quotes relevant to this paper are shown.

## 3.1 The early years 1989-1992 of Disparate Departmental Systems

As shown in Figure 1 below, the prominent concepts in the 1989 documents were 'industry', 'development' (strongly linked to 'infrastructure'), products', 'systems', information' and 'departments', although the concepts of 'collaboration, 'integration' and communications were also prominent. Quotes show that, up to this time, Departments controlled their own information systems, e.g.

[1] https://www.leximancer.com/

> "*The data structures and file formats are not designed to make the information available outside the department. Thus while communication of information within the department is supported, it is difficult to communicate and share data with other government departments and agencies.*"

However there appears to be a user-driven move for change, e.g.

> "*Users of IT systems have recently begun to understand the cost of this limitation and have moved rapidly towards "open systems" with the adoption of standards for computer systems software, programming languages, and communications protocols. This trend will become much more apparent in the next decade as the integration of systems becomes an important issue to allow free exchange of information between different organisations.*"

The IS literature at this time was also growing and taking stock of its cumulative tradition as observed by Alavi and Carlson (1992), whose overview of IS publications in the 1980s showed significant increases in quality publications in all IS topics, including decision science.

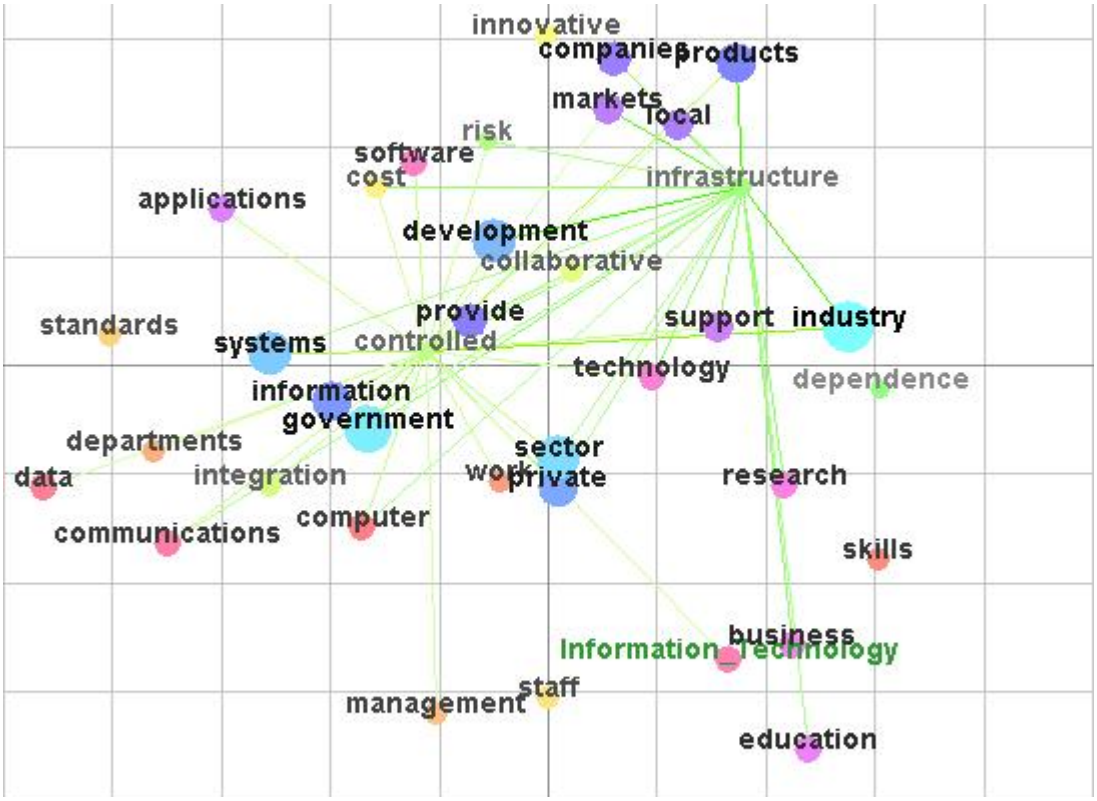


*Figure 1. The Leximancer Concept Map from 1989.*

As shown in Figure 2 below, the prominent concepts in the 1992 documents were 'agency', 'systems', information', 'management' and 'services', while these documents are the first mention of 'network', 'electronic data interchange' (EDI), 'Executive Information System' (EIS) and 'inter-agency'. The EIS concept (which we associate with information for strategic decision-making) has strong links to technology, information, strategy, agency, service, public but no links to inter-agency or infrastructure. A revealing quote on the perception of EIS is:

> "*Establish a minimum data set for service-wide performance indicators and implement a central agency Executive Information System. Establish policies and procedures which will better position agencies to comply with emerging standards.*"

The documents also reveal a "recognition of common data requirements across many agencies" and a need for "sharing of information across agencies through the use of compatible links and, if appropriate, consistent core data formats".

At this time some definitive books on the IS field were published also acknowledge the "big picture" view of IS (eg Boland & Hirschheim 1987; Galliers 1992; Nissen et al 1991).

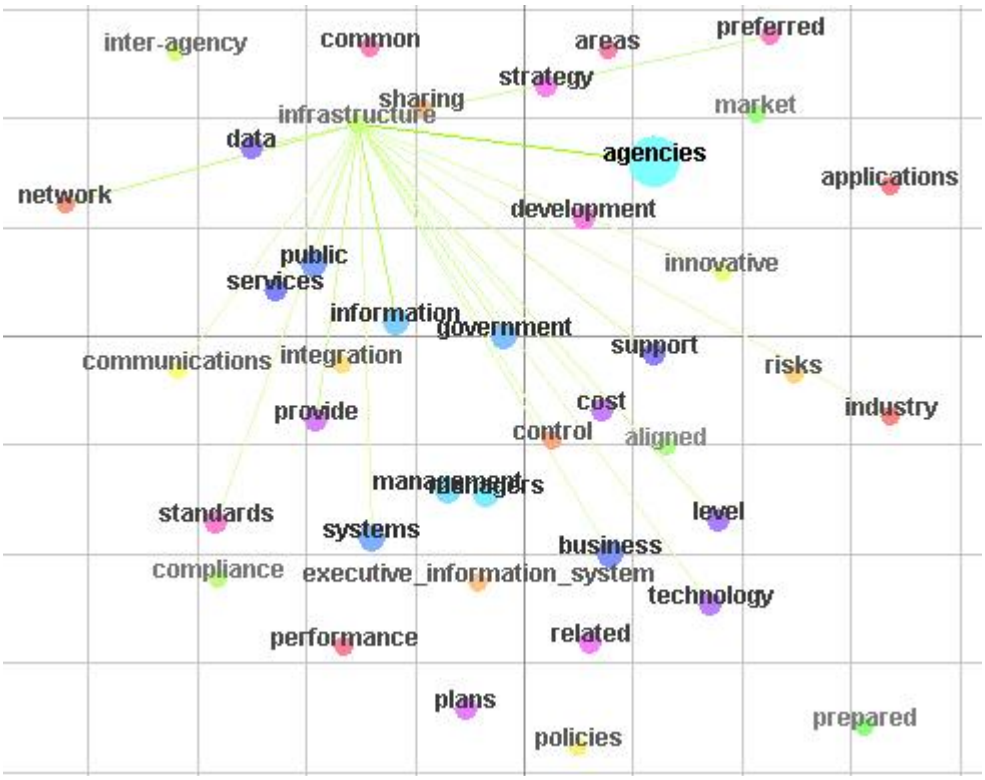


*Figure 2. The Leximancer Concept Map from 1992.*

### 3.2 The years 1997-2001: the Internet, Y2K and the Olympics

As shown in Figure 4 below, the prominent concepts in the 1997 documents were 'services' 'information', 'Internet', and, 'community', 'management'. These documents contained the first mention of the Internet and e-government and the linked concepts of 'information infrastructure' are central. This has two implications for IT strategy: one for a new responsibility of IT for the relationship between government and its citizen constituency through websites and online services; and the other is a more whole-of-government view of IT, influenced by the need to cross-agency cooperation to ensure smooth running of the Olympics and to reap benefits from the global attention on NSW. Evidence for this is the appearance of the concept 'world' on the map and indicates a new outward focus by the State of NSW looked forward to the Olympics in Sydney 2000 as an opportunity to innovate across agencies and beyond as these quotes show:

> "*This visionary infrastructure development will be recognised as a fundamental contribution to the long-term wellbeing of our State. Just as important as this infrastructure development will be the establishment of effective information infrastructure in NSW. Like stadiums and roads, the success of the Olympic Games will be reliant on the State's information architecture*."
>
> *"NSW has the potential to become a global information leader. It has an excellent information technology infrastructure; most Australian-based information technology*

*firms are located in this State; it has a multilingual, well-educated workforce; and it is home to Australia's most innovative small and medium-sized multimedia firms."*

*"connect.nsw will facilitate interaction between government, commerce and community across the State. Delivering the connect.nsw vision will require a management style that allows the pace of change necessary to compete in the information era. A "federated" model is proposed which will centralise some activities and decisions where it would be technically and financially more efficient and decentralises those better managed independently by agencies"*

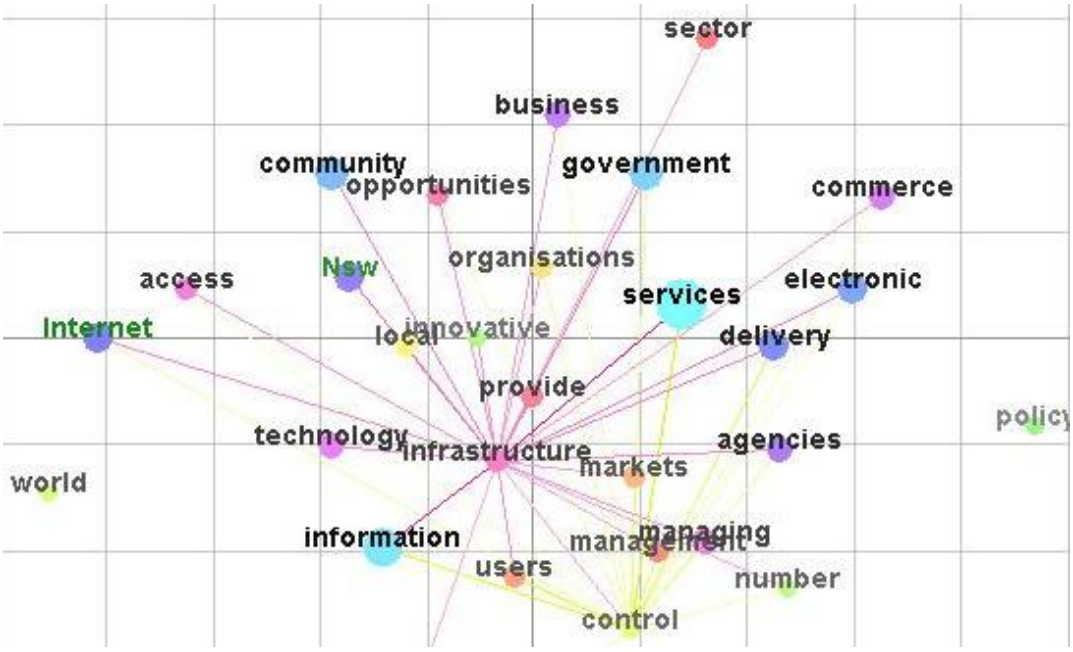


*Figure 3. The Leximancer Concept Map from 1997.*

In contrast to the positive focus on the Olympics, documents on the Y2K problem dominated the work of the IT Department at this time. As shown in Figure 4 below, the prominent concept 'Year_2000' links to concepts of 'problems' and 'control'. Typical statements quoted in the test are "The objective of issuing the guideline was to provide all agencies with a structured approach to the problem and to develop an understanding of the Government's exposure to the problem" and "Y2K Firstly, an online contact database was established to ensure a single source of contact information for all agencies active on the night"

Although the 'Millennium Bug' caused considerable panic towards the end of the twentieth century, there are no Y2K papers in elite IS journals, possibly because the predicted catastrophe that panic envisaged did not occur.

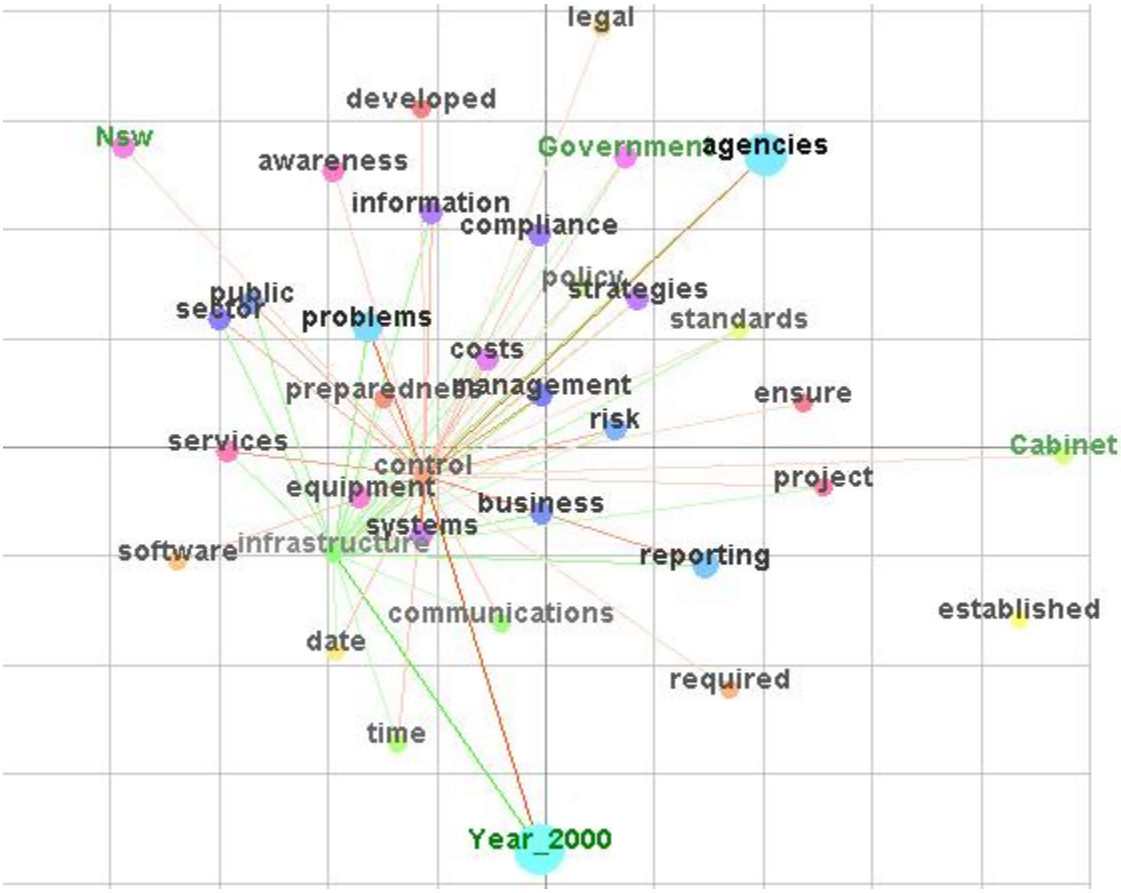


*Figure 4. The Leximancer Concept Map from 1999-2000.*

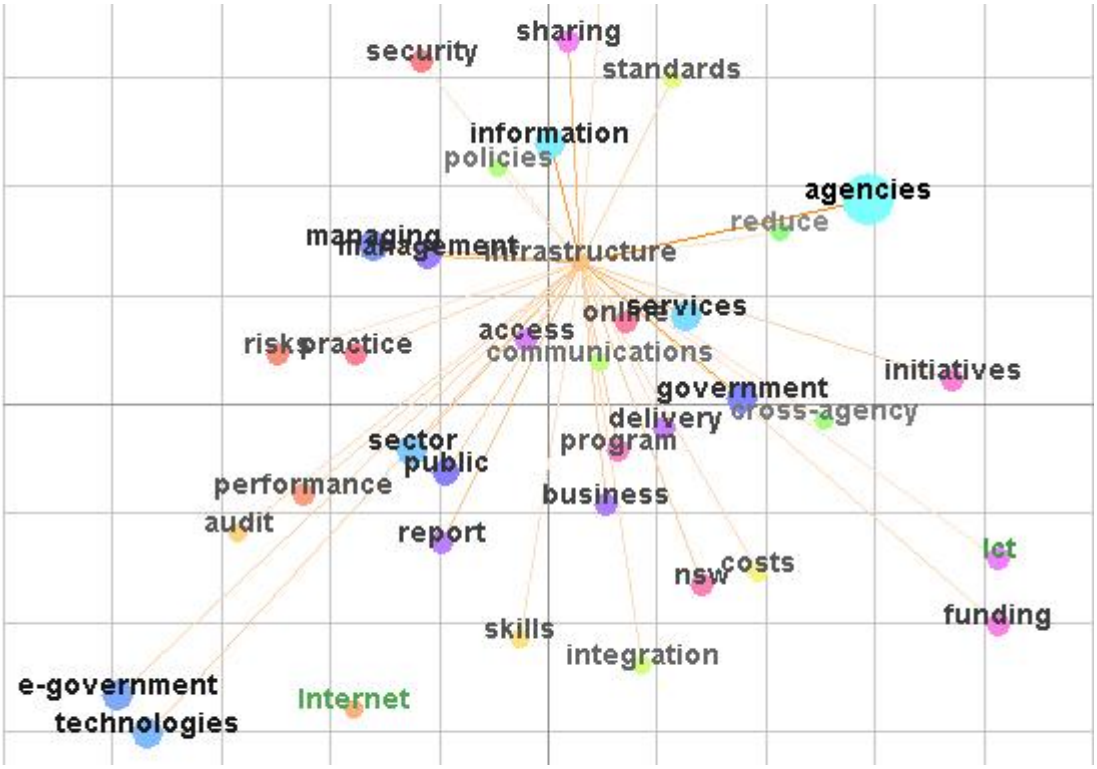


*Figure 5. The Leximancer Concept Map from 2001*

With Y2K and the Olympics out of the way, the main concepts of 2001 as shown in Figure 5 above, were indications that government leaders were taking a "back to local business" approach with concepts such as 'agencies, 'e-government', 'information' and 'services' being prominent. As quoted in the text, a government portal is proposed to:

> "*overcome lack of cross agency cooperation and enable government to concentrate on customers needs rather than what agencies want to deliver provide an infrastructure upon which agencies can build their e-government initiatives accommodate multiple channel access (e.g. telephone, computer, mail) assist in enhancing the management of customer relationships, including streamlining of communication, tailoring offerings and minimising duplication of information gathering.*"

### 3.3 The years 2004-2010: Government as Business

As shown in Figure 6 below, the focus in 2004 was on government as a business with a changing culture of the public service to a more commercial way of acting, as shown by these quotes:

> "*In this context, the role of the CIO is to provide executive-level support for the strategic business planning, financial planning and business process reform of the agency. Details of the relationships between the CIO and business unit managers will vary from one agency to another.*"

> "*An Information Management and Technology (IM&T) Strategic Plan defines the way an agency proposes to manage and enhance its information assets to support its current and future business needs. The IM&T Strategic Plan becomes a tool that agencies use to communicate its IM&T Strategy both internally and externally. The purpose of an IM&T Strategic Plan is to ensure that IM&T activities are aligned with strategic and corporate objectives, and to define the IM&T standards and policies that agencies have in place.*"

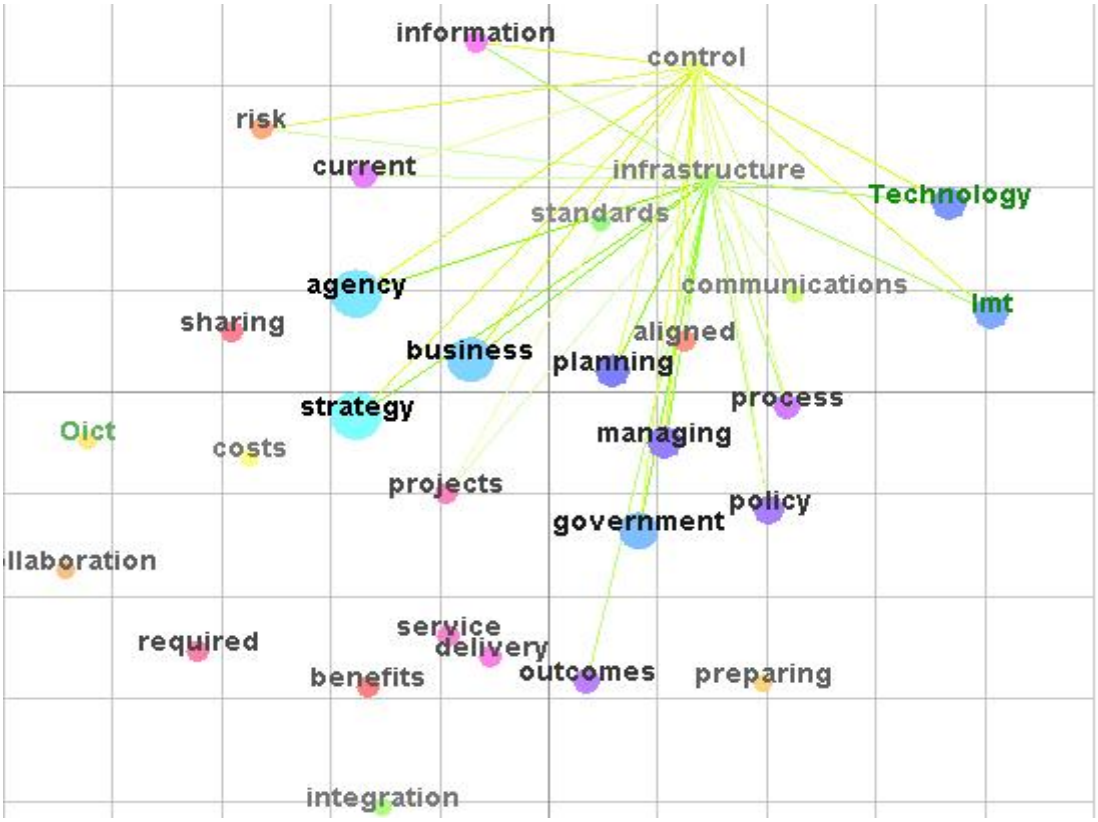


*Figure 6. The Leximancer Concept Map from 2004 with 'business', 'planning', 'process', outcomes' and 'strategy' prominent concepts.*

In Figure 7 below, the Leximancer theme generation facility is use to show the main themes of the map of 2010 documents which are 'business', 'systems', 'strategy', 'management' and 'government'. It reflects the view that all through the period 2004-2010 the emphasis on enterprise systems and the consolidation of agencies and systems as shown by these quotes:

> "*Capital and recurrent ICT spending is reduced through consolidating and sharing ICT services, applications and facilities across agencies, and through government-wide procurement contracts.*"
>
> "*Enterprise Resource Planning (ERP) and related corporate applications application technology infrastructure (databases, business activity monitoring tools, etc) a range of common use applications including business intelligence and CRM tools.*"
>
> "*Data centre consolidation offers the opportunity to rationalise more than 13,000 m2 of data centre space, securing essential future capacity.*"

During this time the NSW government went through a restructure to consolidate its 130 separate agencies into 12 super agencies. This is typical of business restructuring for greater efficiencies of operations (see e.g. Mehta & Hirschheim 2007) and was accompanied by consolidation of information and decision support systems.

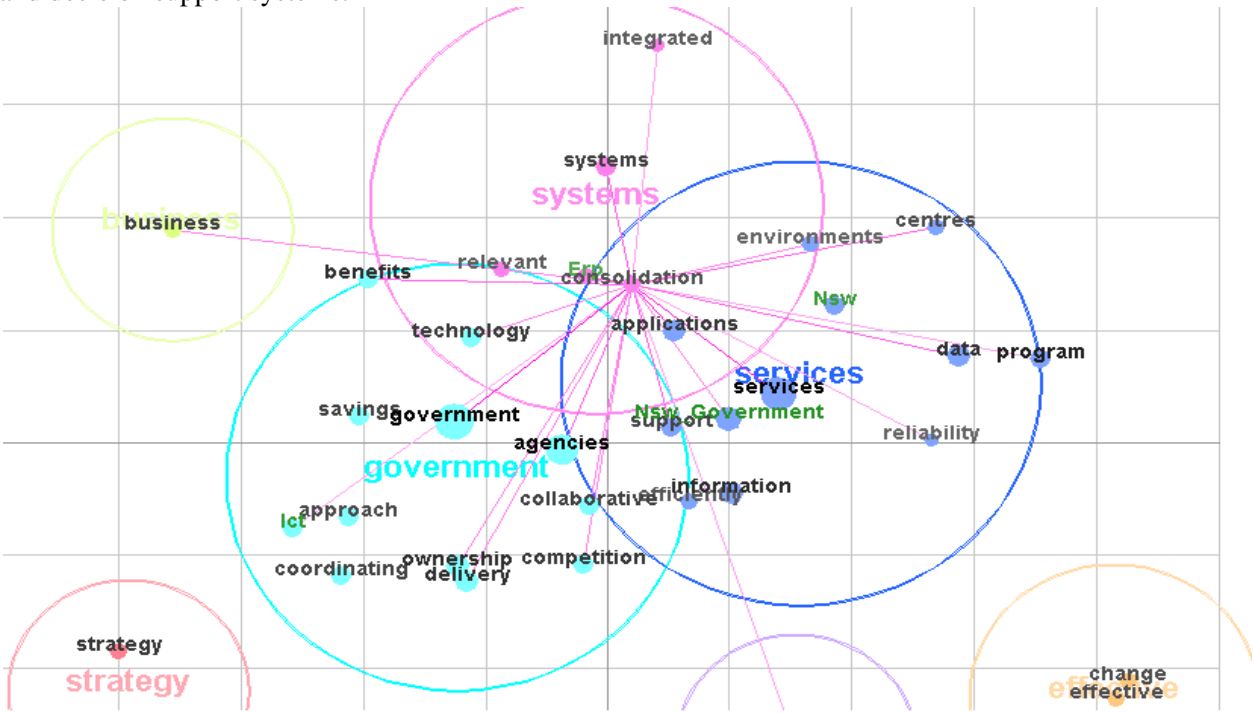


*Figure 7. The Leximancer Concept Map from 2010*

It appears that the strategy of government leaders during this period was particularly business-like and this emphasis is not dissimilar to trends in IS research at this time. According to Sidorova et al (2008) prominent issues of the IS in organisation's literature in the period 2002-2008 were 'supply change management', 'IT for competitive advantage' and 'ERP implementation'. They also note that in the area of DSS the focus was on 'collaboration', 'training' and 'risk management'. There seems very little evidence of innovation, change or complexity as issues of interest and concern.

### 3.4 The year 2011: the Climate Change Factor

When we first saw the concept map from the 2011 documents in Figure 8 below we were immediately surprised and checked that this pattern was consistent among the maps generated by sub-sets of the 2011 documents. This map is unusual as it forms an almost one-dimensional bipolar distribution of concepts compared to the typical maps of Figures 1-7 where concepts are distributed across the whole two-dimensional plane. In Figure 8 there are two distinct clusters of concepts. On the left of are

concepts of ordered management and control, such as 'risk', 'responsibility', monitoring', resources' and 'costs'. On the right are issues associated with information, decisions, people and public access to government. The concepts 'infrastructure', services, and 'future' are central.

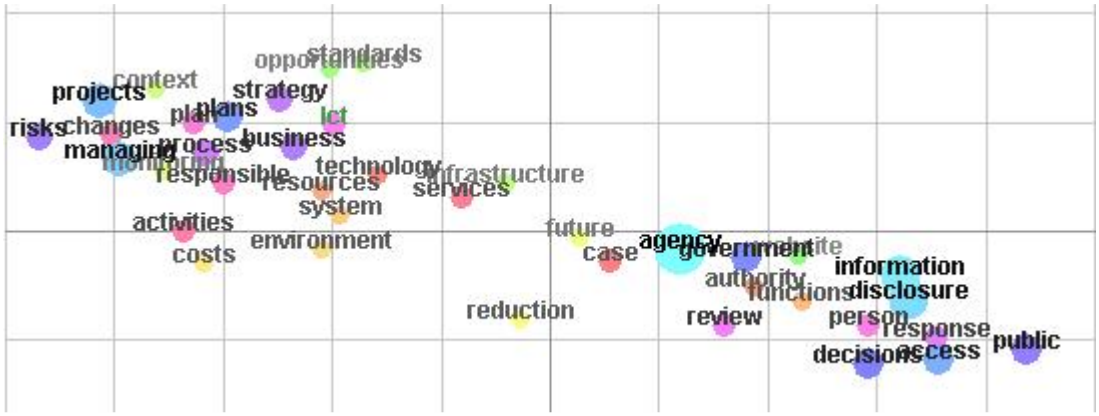


*Figure 8. The Leximancer Concept Map extracted from 2011 Documents.*

Typical quotes on the left side are "*reduce risk by anticipating, evaluating and developing strategies for the management of problems arising during the project*" and "*provide a formal structure against which progress can be evaluated*". A quote from concepts on the right is more open "*provide a mechanism for involving a wide variety of interested parties or stakeholders in the project*". This illustrates two very different styles of leaderships and strategic decision-making.

We suggest that the cluster of concepts on the left hand side of Figure 8 represents the predominantly top down focus of IS research and practise observed in the 2004-2010 period of our study as described above and reflected in much of the IS literature of this time. The cluster of concepts on the right appear to represent added complexity, which in the case of government climate change adaptation activities involve the opening up of information gathering and decision-making to public access for community-based action as indicated in Table 1. The central position of the concept of 'infrastructure' indicates the need for information systems related to all concepts. This would involve data sets from all government agencies and external sources. In the following discussion we turn to recent literature on 'information infrastructures' for an explanation.

# 4 DISCUSSION

The emergent bipolar pattern of the 2011 concept map appears to reflect a spit between 'order' (the left side of Figure 8) and that of 'unorder' (on the right) as defined in the Cynefin Sense-making Framework (Kurtz &. Snowden 2003). The cluster on the 'ordered' left of Figure 8 includes concepts of managing risk, monitoring, planning, costs and standards. These are all traditional internal concerns of government. We see the right side cluster as 'unordered' because it includes the concepts of 'people' and 'public access', heralding a new challenge for governments of more open community engagement in the era of social media. Interestingly from our perspective, the concept 'decision' is in this 'unordered' cluster while the concept of 'strategy' is on the left.

This finding led us to consider the notion of 'information infrastructure' as more appropriate that of an 'information system' to describe decision support for the climate change adaptation activities of the NSW government in the current complex and dynamic context. We suggest that the ordered/unordered split is comparable to the top-down and bottom-up distinction in Ciborra's framework for the Dynamics of Information Infrastructure in Figure 9. The concept of 'information infrastructure' was introduced in the early 1990s adding a focus on networks and infrastructures to the prevailing organizational systems concentration of IS research and allowing for emergent perspectives on information systems development (Star and Ruhleder 1996).

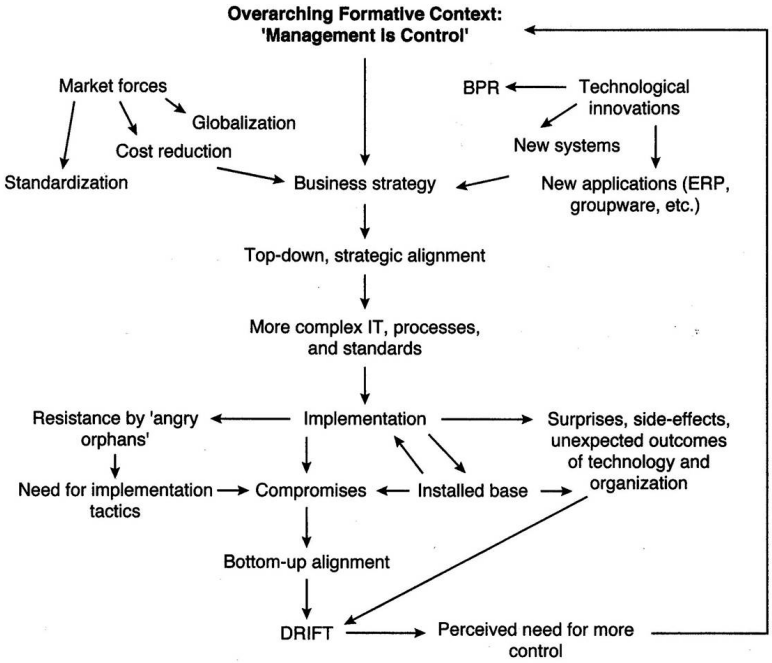


*Figure 9. The Dynamics of Information Infrastructure (Ciborra, 2000)*

The notion of 'information infrastructure' received limited attention through the 1990s and 2000s but has re-appeared in more recently literature. Our research results provide an explanation for this. The concern for Y2K in the 1990s and a business consolidation focus in the 2000s are only now giving way to renewed concern for innovation and change in the face of external challenges such as the global financial crisis, cyber-crime and climate change. Information infrastructure is now re-defined as "a shared, open (and unbounded), heterogeneous and evolving socio-technical system consisting of a set of IT capabilities and their user, operations and design communities" (Hanseth & Lyytinen 2010 p5). In Ciborra's (2000) framework (Figure 9), we see an alignment of our results from the last two decades with different parts of this framework leading to a sharp focus on the element of "surprises, side-effects, unexpected outcomes of technology and organization" in respect of our 2011 results.

In Figure 10, we depict the concentration of concepts from each Leximancer map on the Dynamics of Information Infrastructure framework of Figure 9. We see a trend from the top-down alignment of "management in control" in the 1990s with the increasing influence of the Internet and e-government with a reversal of focus on standards in 1999 in the face of the Y2K problem. This relaxed downwards in 2001 with an evolution of cross agency e-government services. However, the expanded use of enterprise-wide ERPs through the rest of the 2000s brought back the emphasis of top-down "management in control". We see the beginnings of a break away from this in the 2010 results in the turmoil of the restructures which consolidated government into 13 super agencies.

Emerging in 2011 is a fascinating cluster of concepts on the right side of the concept map of Figure 8 and the "surprises, side-effects, unexpected outcomes" that lead to "drift" linked to "bottom up alignment" in the Framework of Figure 9. We suggest that a major contributor to this cluster is the current climate change adaptation activities currently undertaken by the NSW government. Two major developments fall into the category of "surprises, side-effects, unexpected outcomes".

In the first place, we observe the enormity of the challenge of providing decision support for the activities associated with adaptation to climate change which is complicated by the need to involve such a diversity of government agencies and other bodies. Each of these collects its own this data for its own original purpose and the owners never properly envisaged the prospect of combining the different data sets to enable the inter-agency data exchange necessary for long term integrated planning and management. The consequence of this is that, while the individual datasets may be suitable for the collecting agency, they may not be valid when combined with other data from other

agencies. The problem is thus too complex for a top-down ordered approach to decision support. The providing the information needed for each adaptation project requires a bottom-up, user-driven open and flexibility information architecture that is unprecedented in government.

In the second place, the increasing need for government to engage with the public on climate change matters has coincided with the pervasive use of social media. In particular we note the use of Facebook and Twitter by police, local government and emergency services during recent natural disasters across Australia. We anticipate a growing use of social media to allow information sharing across the external boundary of government for long-term adaptation planning. This again is an unprecedented change to the way in which governments have traditionally engaged with citizens.

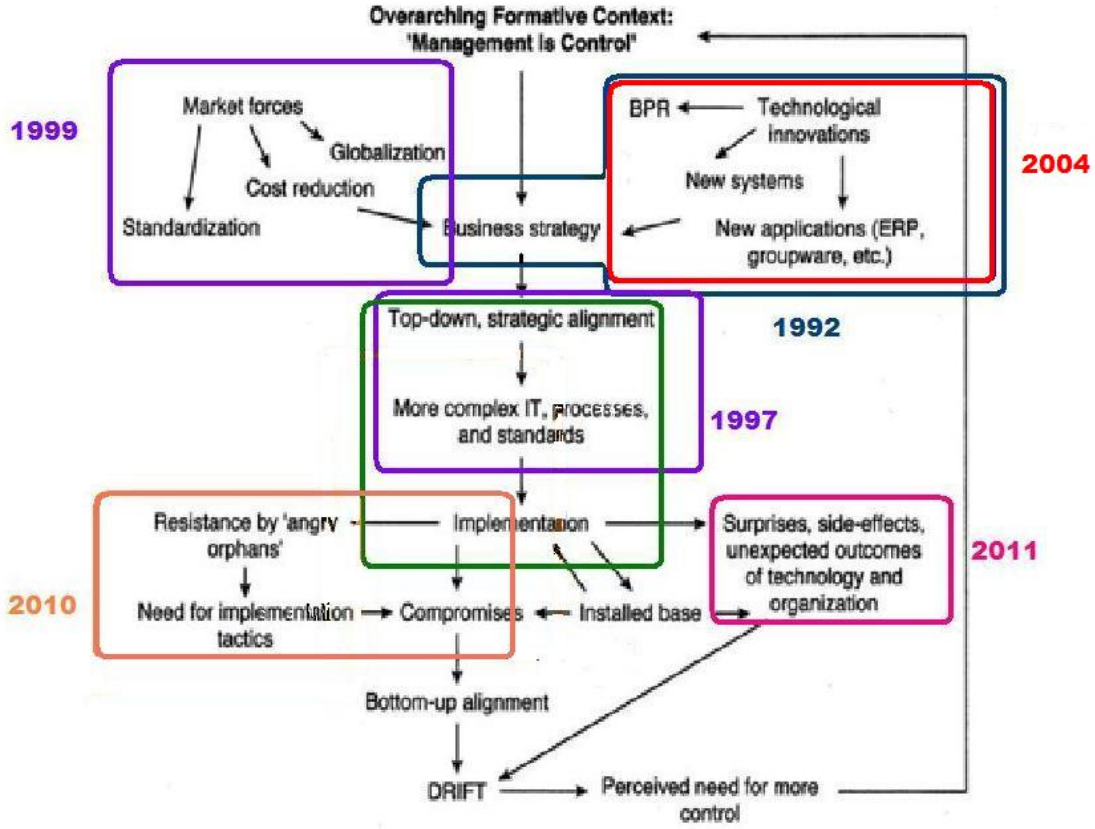


*Figure 10. Mapping of sets of concepts from our results onto the Framework of Figure*

# 5 CONCLUSION

In this paper we suggest there is value in undertaking a historical investigation of IS support for strategic government decision-making. We show that the emergent nature of information infrastructure recognises that, while enterprise systems and application arise from a top down alignment process, resistance and unexpected side effects that arise over time lead to a continually changing infrastructure often driven from the bottom up. This emergence is particularly relevant in the context of information infrastructure support for leaders of climate change adaptation activities because of the length of planning frames, changing technological solutions, and the multitude and variety of stakeholders. The uncertain nature of future decision-making means that traditional top-down alignment adopted within government organisations are unlikely to deliver the systems and technologies needed to enable decision-making on climate change adaptation. We anticipate more bottom-up development of agile information infrastructures with inter- and extra- organizational data consolidation, ensuring accuracy in consolidated data for the future and the real time integration of social networking technologies and government systems. We suggest that in 2012 and beyond, the drive from "surprises, side-effects, unexpected outcomes" to Drift may be such to sometimes reverse the direction of flow in the Dynamics of Information Infrastructure Framework of Figure 9 so that sometimes 'bottom-up alignment" influences critical decisions of business strategy.

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